An Interactive Algorithmic Procedure for Promoting Individualized Environmental Tutoring

F.A BATZIAS, A. KARAGIANNOPOULOU, O. KOPSIDAS
Department Industrial Management and Technology
University of Piraeus
80 Karaoli and Dimitriou Str., 18534 Piraeus
GREECE
fbatzi@unipi.gr

Abstract: - This work presents an interactive algorithmic procedure (IAP), including 21 activity stages and 4 decision nodes, for promoting individualized environmental tutoring. The proposed scheme is based on a modification of Holland's methodology for quantifying the distribution of personality types while determining the degree of environmental awareness of young people in order to evaluate their attitudes and beliefs as regards their willingness to be actively engaged with the environment and provide educators valuable information that they may use to formulate proper educational material. The framework has been implemented in a sample of 240 students of secondary and tertiary education. Further to quantitative results obtained by estimating various kinds of correlations based on the answers to the questionnaire we designed/circulated, we have indicated that at least two personality types, the investigative and the artistic (after Holland), should be divided into sub-categories in order to establish more effective interactive links with the students that belong to these sub-categories. In accordance of these findings, we prepared paradigmatic assignments to serve as prototypes.

Key-Words: - environmental education, Holland's theory, questionnaire design, hypothesis testing, vocational typology, environmental education

1 Introduction

The central hypothesis in Holland's theory is that the vocational interest is a key aspect of the individual. People can be described by their degree of resemblance to six theoretical personality types: Realistic (conforming, hard-headed, practical, inflexible, un-insightful), Investigative (independent, intellectual, precise, rational, reserved), Artistic (emotional, imaginative, introspective, nonconforming, sensitive), Social (cooperative, friendly, helpful, responsible, warm), Enterprising (agreeable, ambitious, energetic, extroverted, sociable), and Conventional (conforming, conscientious, efficient, obedient, practical) [1]. Each type is characterized by distinctive preferences, outlooks, competencies, and self perceptions.

The practical people prefer to work with things in occupations such as chefs, air traffic controllers, carpenters and builders. The investigative types are good in data acquisition and, thus, they are usually found in technical occupations, such as computer programmers, or as engineers and scientists. The artistic types work best with ideas and may be found as artists, musicians, or decorators. The social types prefer to work with people, thus, they are commonly engaged in teaching, counseling and care services. The business types prefer to work with people and data, choosing occupations on management, trade, business and politics. The conventional types are good in handling and treating data, selecting professions relevant to accounting, administrative support and legal or military/police industry.

In practical applications, information about a person's preferences, goals, and self estimates is used to assess the degree to which an individual resembles each of the six personality types; these types are not always clear and pure, and a variety of mixed personalities are not uncommon. At what level and extent a certain issue/aspect/problem will influence a person is determined by one's intelligence, self-knowledge and professional information/ background [2].

Environmental attitudes are conceptualized in terms of behavioral theory as being composed of beliefs towards an object [3]. The environment as an object is difficult to define; it may be an attitude object which has been forced on the respondent by journalists and researchers, but it may not make sense to respondents who see the environment much

more in terms of its component parts that they personally experience. The factors that may influence one's environmental attitudes are: knowledge, background, experience, perception, values and context. Environmental concern appears to be a specific belief which is largely embedded in cognitive structures and should be considered an opinion rather than an attitude. While changes in this opinion have been documented, it is not clear that environmental attitudes or values have shifted, although attitudes have most probably became more differentiated over the last decade.

The theory of Holland's vocational personalities has been confirmed and validated by many researchers [4-8]; the psychometric tools available in the literature are in the form of census questionnaires used to assess job characteristics. The investigation of the attitudes of young people towards environmental issues is very important to environmental education, whose role is to shape positive behaviors towards the environment. Linking environmental and vocational type helps grouping of personalities.

This work presents an interactive algorithmic procedure (IAP) for promoting individualized environmental tutoring. The proposed scheme is based on a modification of Holland's methodology for quantifying the distribution of personality types while determining the degree of environmental awareness of young people in order to evaluate their attitudes and beliefs as regards their willingness to be actively engaged with the environment and provide educators valuable information that they may use to formulate proper educational material.

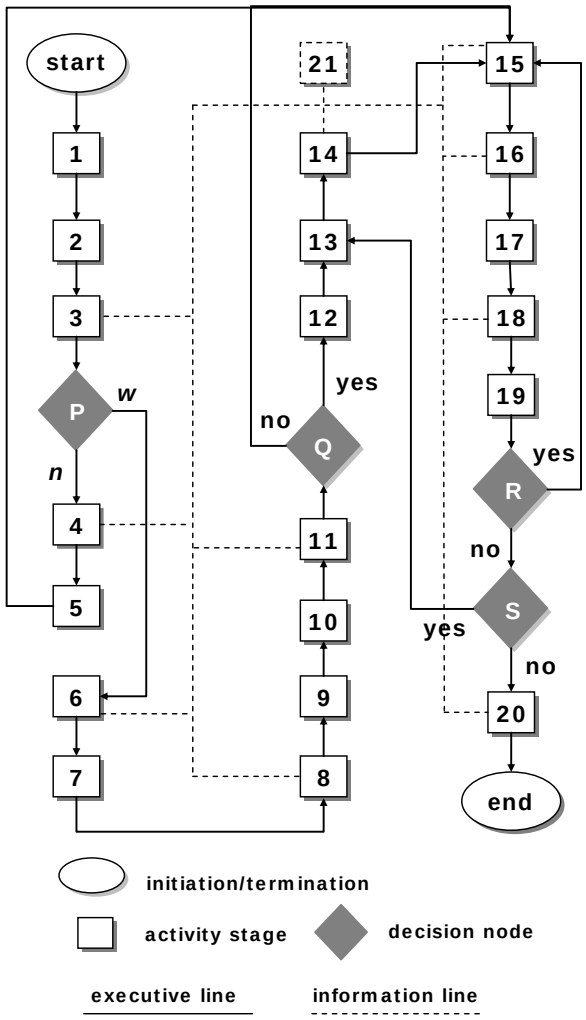

Figure 1. The interactive algorithmic procedure (IAP), designed/developed by the authors for promoting individualized environmental tutoring.

2 Methodology

The methodological framework designed/developed by the authors, under the form of an algorithmic procedure with 21 activity stages and 4 decision nodes (interconnected as shown in Fig. 1), for promoting individualized environmental tutoring, is presented below.

1. Definition of the sampling domain within the schools of secondary and tertiary education, where the population of the interviewees is attending lessons.
2. Determination of the degrees of freedom that the legislation, generally, and the program of the schools mentioned above, specifically, allow the teaching staff to use for assigning essays under the form of homework.
3. Determination/identification of the extent that the teaching staff is willing to take advantage in order to assign essays on individual basis (including work in groups initially that becomes individualized later on).
4. Design of questionnaire based on representative types (after Holland [1]), aiming at the investigation of the characteristics of each category in comparison with the other ones.
5. Circulation and evaluation of the questionnaire, including statistical analysis of the answers, putting emphasis on the partial correlation between them.
6. Inter-and multi-disciplinary selection of topics of environmental interest, covered by different course subjects.
7. Selection of experts from the teaching staff and the consultants affiliated with the school.

8. Assignment of weights to the vector of personality characteristics designed for each category of types.
9. Design, circulation, and evaluation of the weighted questionnaire, including correlation between the answers and discrimination/identification of sub-categories based on cluster analysis of individual answers.
10. Sensitivity/stability analysis of clusters as regards plausible change of weights in both ways, on (i) *a priori* grounds (within ranges defined together with weights at stage 8) and (ii) *a posteriori* grounds (within ranges resulted after the evaluation/processing at stage 9).
11. Investigation of the weaknesses arisen in answers evaluation and especially in sensitivity/stability analysis of clusters.
12. Design of weighted post-questionnaire aiming at extraction of further information at higher granularity level.
13. Discrimination of the initial student samples into sub-samples in accordance with the additional information aiming at.
14. Circulation of the post-questionnaire and evaluation of answers.
15. Searching in relevant literature to collect materials suitable for demonstrating the environmental point of view of conventional topics incorporated into the classical syllabi of the usual courses.
16. Synthesis of representative case examples, covering a wide variety of environmental subjects, to be used as paradigms for homework by the students.
17. Preparation of a list of titles referring to environmental subjects and corresponding to all personality (sub-)categories identified so far.
18. Assignment to each student and establishment of a computer-aided help line to offer web-based support for relevant literature retrieval.
19. Presentation of the environmental essays and discussion upon the most representative as well as the most extraordinary of them.
20. Concluding remarks on the presentation/ discussion of the environmental essays, emphasizing the lessons learnt on the cognitive procedure itself so that the respective experience could be used within the next round.
21. Development/operation/updating of an internal KB and searching in external KBs by means of an Intelligent Agent, according to [9].

P. Is this extent narrow or wide? (*n* or *w* in Fig. 1, respectively)?

Q. Is higher granularity of information required to perform the activities described in the previous stages 9-11?

R. Is the great majority of students presenting environmental essays in favor of a follow-up?

S. Is a significant number of students presenting environmental essays in favor of a follow-up?

3 Implementation

The methodological framework described above has been implemented in two high schools of Athens, in an undergraduate program of the University of Piraeus related to industrial management, and in a post-graduate course at the same University related to environmental protection systems (stage 1). In Greek primary and secondary education, environmental education is included in the curriculum, yet it still depends on the educators' will to be applied (stage 2). Administration bottlenecks, in addition to the uncertainty teachers are feeling concerning their knowledge background on environmental issues, the lack of existence of a suitable educational or training material and the restriction of the school timetable, usually hamper the environmental education course.

The initial survey was conducted within 20/5-20/6 2011 (stage 5) with students samples, aged between 15 and 24, of both sexes, interviewed in person, while a post questionnaire was circulated in the two high schools four months later (stage 14).

Holland's methodology has been used to design a questionnaire with 42 Likert-type questions, grouped in seven to six clusters according to Holland's vocational types. Each cluster includes questions of vocational interest and one or two of environmental interest. Respondents filled the questionnaire by themselves at class, at the presence of their teacher/lecturer for any clarification needed. Some problems have been registered during the completion of questionnaires, mainly due to miscomprehension of the questions (especially at the lower levels of education), lack of time, and the influence of the classmates.

Scoring followed the five-point scale, from 1= strongly disagree to 5 = agree completely. At the end of each questionnaire the student had to describe him/herself by ranking the six personality types with descending order of preference. That

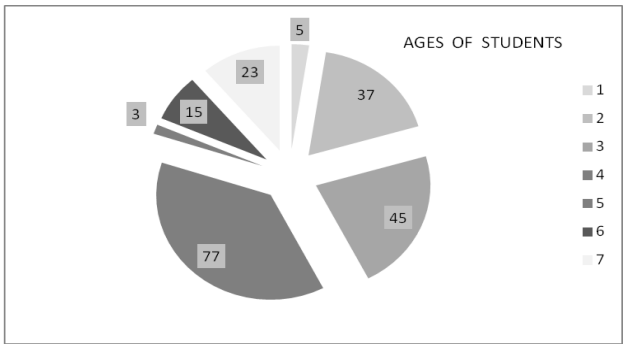

Figure 2. Students' ages chart, where: 1=14; 2=15; 3=16; 4=17; 5=18; 6=22; 7=24 years old.

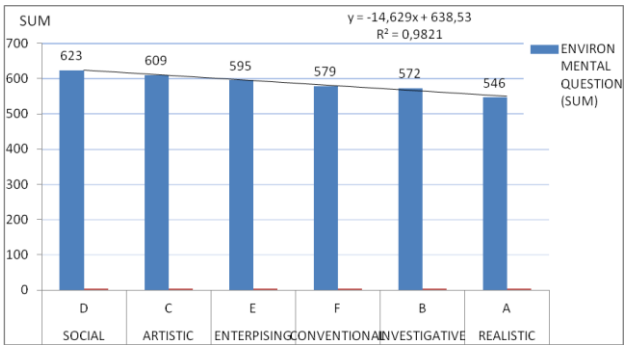

Figure 2. Environmental Question (SUM) of each type.

gave two sets of scores (i.e., the summation of the scores that each respondent gave to the questions) on occupational preferences, one from the responses to the questions and another from his ranking preferences (initial and final, respectively). The questionnaires data were registered in excel and processed (stage 5) with SPSS-Statistics, using R^2, weighted rank (r_T), Pearson's, Kendall's and Spearman's coefficient correlations [10,11].

The students sample of the first round (stage 5) consisted of 47% women and 53% men. According to the students' level, 40% of the sample cane from a technical vocational school, 42% from high school, 7% was in undergraduate university courses, and 11% in post-graduate courses. The age distribution is given in Fig. 2. As regards the personality types, 12.3% of respondents belong to type A, 17.5% are registered as type B, 15.8% fit in type C, 25.7% belong to type D, 10.5% are type E, and 18.1% are assigned under type F.

The correlation of personality type with the degree of environmental awareness has been used herein as a tool to determine the approach (extend, intensity and depth) that environmental education should follow on each of the six Holland's types. The most friendly type to environment is type D (Social), followed closely by type C (Artistic), type E (Enterprising), type F (Conventional), type B (Investigative), whereas type A (Realistic) appears the least predisposed. The correlation between personality types and awareness of respondents on environmental issues (Fig. 3) showed that social type is the most sensitive to environmental issues. We have associated the type of personality of each respondent, as it is deduced from his/her answers, with his/her personal beliefs, as they are derived from his/her ranking of types: the internal consistency of the first type selected is 43%, whereas the internal consistency between the first and second choice is 81%. We have also associated each type's environmental question with the other questions in the group. The results gave R^2 values between 0.71-0.95, indicating medium to high correlation between the average values of scores of all other questions and the score of question that measures the environmental sensitivity.

The top-down correlation analysis, considering the ranking score of the respondents and the classification chosen by the respondent, gave the following weighted rank correlations, r_T: (i) for the technical vocational school students, the range is between -0.053 and +0.707, with an average value of 0.355 and a standard deviation of 0.78; (ii) for the undergraduate students, the range is between +0.159 and +0.771, with an average value of 0.482 and a standard deviation of 0.218. Evidently, there is significant agreement between the two rankings for the six personality types, at least for the higher values of correlation. We formed the hypothesis for the Pearson's, the Kendall's and the Spearman's correlation coefficients. H_0 : if r=0, then there is no correlation. H_1 : if r >0 or r <0 , then there is correlation. The confidence level is a=5% . Thus, if p-value (two-tailed) < 0.05 , then H_0 is rejected and H_1 is accepted. If r > 0, there is a positive correlation whereas if r < 0, there is a negative correlation; in these cases, H_0 is accepted and H1 is rejected. The results are presented in Table 1.

Table 1. Coefficients of Correlation

Holland's Type	$r_{Pearson}$	$r_{Kendall}$	$r_{Spearman}$	p(two-tailed)
A	0.382	0.292	0.382	<0.05
B	0.315	0.252	0.329	<0.05
C	0.411	0.324	0.429	<0.05
D	0.180	0.158	0.208	<0.05
E	0.219	0.154	0.204	<0.05
F	0.348	0.274	0.350	<0.05

As there is no linear relationship between variable "Initial Score" and "Final Score", our assumptions

are based on Kendall and Spearman correlation coefficient.

The representative case examples synthesized by the group of experts to be used as paradigms for homework by the students, according to stage 16 of the IAP, are designed as combined modules to facilitate presentation/discussion and conclusions extraction, according to stages 19 and 20. The combined modules refer to a unique concept or corpus. In the simple case, where the concept/corpus is 'recycle', the corresponding assignments for the personality types (i) realistic, (ii) social, (iii) enterprising, and (iv) conventional, are the following:

(i) Defining 'sorting at source' as the separation/ classification of solid waste, according to type of material, at the location where the waste is generated, make a list of actions that should be accomplished in a mid-class household for effective sorting, temporarily storing and transfer to the nearest collection points, which should be localized on a map of your region.

(ii) Determining ways of increasing 'environmental sensitization' of the public, make a list of actions that a municipal service or a non-governmental organization might use in order to be more effective towards this direction in general and especially in the domain of materials recycling.

(iii) Defining 'corporate environmental responsibility' for an industrial enterprise of your choice, make a list of actions that should be accomplished by a typical plant of this kind, putting emphasis on the recyclability of materials to be used and the energy saving that might be achieved.

(iv) Bearing in mind that the five stages of recycling are: primary storing at source, collection, secondary sorting at collection centers, compaction/baling, and transportation/ storing to corresponding processing/recovery industrial units, make a list of actions that should be undertaken at the interfaces between these stages (including the human factor and the communication networks), so that the whole procedure is functioning satisfactorily.

More complicated paradigms are synthesized when the evaluation of the answers to the post-questionnaire, quoted in stages 12-14, suggests splitting of personality types into sub-categories. In our case, such sub-categories seem to be proper for the investigative type (inclined to express himself in a symbolic or a narrative way) and the artistic type (oriented to visual arts or literature or musical expression). The characteristic assignments designed by the experts are quoted subsequently, in order of their presentation above.

– Comment on the effects of international cooperation on minimizing the ozone hole and its environmental impact during the next decade, taking into account that around 2000 the maximum concentration had been reached, and this environmental damage seems now to be stabilized with a tendency to be decreased, although with low rate, since the CFCs (already banned on a global scale) are decomposed very slowly; how the lessons learnt from this coordinated world-wide action could be applied to other cases (e.g., green house effect due to CO_2 accumulation leading to global warming).

– Comment on the spoil of view of S. Croce, as seen (by several million visitors per year) from the last floor of Palazzo Vecchio, Florence (shown in Fig. 3), and generalize your aspect as regards visual pollution due to TV-antennas, including proposals on measures that should be taken to prevent this kind of environmental damage.

– Comment on the passage *"The forests are disappearing, the rivers are running dry, the wild life is exterminated, the climate is spoiled, and the earth becomes poorer and uglier every day"* found in the play 'Uncle Vanya – Scenes from Country Life in Four Arts' by Anton Chekhov, where Doctor Astrov (the *alter ego* of the author, who was also a doctor) expresses his ecological feelings, and compare the present (2011) situation, from the environmental point of view, with that of the last decade of the 19th century when the play was written (1896).

– Comment on the impression made to the audience (including the intention of the soundtrack composer) by listening to the widely known waltz "The Blue Danube" composed by Johann Strauss II

Figure 3. View of the Basilica of Santa Croce from the last floor of Palazzo Vecchio, Florence.

, as a soundtrack to a documentary film describing this river in its present (2011) situation, as regards the relevant environmental parameters/indicators (color, clearness, flow rate) in contrast with the situation when the original work was written (1866).

– Comment on the chemical knowledge required to understand the creation/expansion of the ozone hole by analyzing the parameters contributing to $2O_3 \leftrightarrow 3O_2$ equilibrium in the stratosphere, and propose further measures to be taken on a world-wide basis in order to accelerate the extinction of this environmental damage.

4 Discussion and Conclusions

Using the modified questionnaire of personality types of Holland, without direct reference to them, our research has helped to elicit indirectly the views of students about the environment, so as to provide educators valuable information that they may use to formulate a proper educational material. Certain conclusions have been drawn at comparing personality types to environmental awareness, assigning a degree of environmental predisposition to each type.

Social is the first type of personality that is sensitive to environmental issues. The causal relationship that form the social type fully justifies this predisposition, as the main characteristics of the type are consistent with environmental sensitization: the social type is friendly and responsible, he enjoys team work, he prefers educational activities, he cares for the public benefit and he tries to maximize social welfare. After all, the environment is a public good and its protection relies on willingness of the citizens.

The second type of personality that is sensitive to environmental issues is the artistic one. This type develops positive feelings about the environment, is creative and unconventional. For this type, clean environment is a source of inspiration and creativity.

In conclusion, we have proved the functionality of the Interactive Algorithmic Procedure (IAP) we developed in order to promote individualized environmental tutoring in schools of secondary and tertiary education. Further to quantitative results obtained by estimating various kinds of correlations based on the answers to the questionnaire we designed/circulated, we have indicated that at least two personality types, the investigative and the artistic (after Holland), should be divided into sub-categories in order to establish more effective interactive links with the students that belong to these sub-categories. In accordance of these findings, we prepared paradigmatic assignments to serve as prototypes.

Acknowledgements:
Financial support provided by the Research Centre of the University of Piraeus is kindly acknowledged.

References:

[1] J.L. Holland, *Making Vocational Choices*, USA, Psychological Assessment Resources, 1997.

[2] G.D. Gottfedson, J.L. Holland, *Dictionary of Holland Occupational Codes*, USA, Psychological Assessment Resources, 1982.

[3] A. Kyridis, E. Mavrikaki, H. Tsakiridou, J. Daikopoulos, H. Zigouri, An Analysis of Attitudes of Pedagogical Students Towards Environmental Education in Greece, *International Journal of Sustainability in Higher Education*, Vol. 6, 2005, pp. 54-64.

[4] N.E. Amundson, J. Harris-Bowlsbey, S.G. Niles, *Essential Elements of Career Counseling: Processes And Techniques*, USA, Pearson Merrill Prentice Hall, Colombus Ohio, 2nd ed., 2008.

[5] T.A. Heberlein. *Environmental Attitudes*, Madison, Wisconsin, Abhandlungen, ZfU 2/81, pp. 241-270.

[6] T.A. Timmerman, A Closer Look at the Personality Characteristics of Out-Placed Executives, *Journal of Business and Psychology*, Vol. 12, 1997, pp. 55–66.

[7] J.W. Rojewski, B. Yang, Longitudinal Analysis of Select Influences on Adolescents' Occupational Aspirations, *Journal of Vocational Behavior*, Vol. 51, 1997, pp. 375-410

[8] S.J. Motowidlo, W.C. Borman, M.J. Schmit, A Theory of Individual Differences in Task and Contextual Performance, *Human Performance*, Vol. 10, pp. 1997, pp. 71–83.

[9] F.A. Batzias, E.C. Markoulaki, Restructuring the Keywords Interface to Enhance CAPE Knowledge via an Intelligent Agent, *Computer Aided Chemical Engineering*, Vol. 10, 2002, pp. 829–834.

[10] J.H Zar, *Biostatistical Analysis*, USA, Prentice Hall International,1996, pp.371-406.

[11] B. Bolton, Discriminant Analysis of Holland's Occupational Types Using the Sixteen Personality Factor Questionnaire. *Journal of Vocational Behavior*, Vol. 27, 1985, pp. 210-217.